# NOTES ON SOME INJURIOUS LEPIDOPTERA FROM JAVA

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Abstract

The first of the following four papers treats the biology of two species of Hepialidae, *Hepialiscus* (*Palpifer*) *sordida* (Snellen) and *Endoclita* (*Phassus*) *sericeus* (Swinhoe) in Central Java. The first species lives in tubers and other subterraneous parts of monocotyl plants, the second species is a ring borer. The second paper presents a survey of the biology of several Indomalayan wood-boring Cossidae and bark-feeding Squamuridae (Arbelidae) forming an addition to ROEPKE's monograph "The Cossids of the Malay Region" (1957). *Zeuzera indica* Herrich-Schäffer and *Xyleutes strix* L. are treated in detail, while other species of these two genera and of *Cossus, Phragmataecia,* and *Squamura* are dealt with briefly. A summary is given of various modes of life and association of some groups of species with respective host plants. The third paper gives the remarkable biology of two Pyralid bamboo borers: *Chilo fuscidentalis* Hampson, gregarious larvae of which cause characteristic injury to sprouting bamboo culms in West Java, and *Eschata chrysargyrea* Walker, boring in young bamboo in Central Java. Finally, the fourth paper is a note on the biology of *Amphitales episcopopa* Meyrick (Aegeriidae), a bark borer of *Actinophora fragrans.*

## INTRODUCTION

The four papers published in this issue have no other connection with each other than their being the result of the author's work as forest entomologist of the former "Instituut voor Plantenziekten" at Buitenzorg (Bogor), Java.

The data of the first two papers have been mainly collected at a field station for forest entomological research in the teak area near Gedangan, a village in the Semarang District, Central Java.

The paper on the bamboo Pyralidae is largely a compilation of data collected by Indonesian personnel during the Pacific War.

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## 1. BIOLOGY OF TWO SPECIES OF HEPIALIDAE

### Hepialiscus (Palpifer) sordida (Snellen)

In my book on the pests of Indonesian crops (1951) I have shortly characterized this species as a borer found at some depth in the soil in tubers of *Dioscorea, Alocasia,* and *Amorphophallus.* On my request the personnel of the field station at Gedangan took considerable pains to unearth a number of the larvae for observations and breeding experiments in 1933—1934. The following main data are extracted from their field notes, arranged according to the host plants.

*Dioscorea alata* L. (Dioscoreaceae) ("uwi brongkol"), growing either wild or

semi-cultivated, producing a tuber fairly deep in the soil. The tuber contains an itching substance but can be consumed when properly prepared. From these plants ten borer specimens were collected; seven nearly mature larvae, 25—30 mm in length, were moved to a fresh piece of tuber; six pupae were finally obtained from which four moths emerged.

*D. pentaphylla* L., ("katak"), a seldom cultivated plant. A single larva, 20 mm, was found which soon succumbed.

*Alocasia macrorrhiza* Schott (Araceae), ("senthé"), has a thick edible stem. From subterranean parts 30 larvae could be collected; seven moths emerged in the laboratory. Besides, from 245 apparently infested plants, transplanted in a large outdoor cage on September 21st, 40 moths were obtained between October 25 and November 15. One couple copulated in the cage on October 31st.

*Gloriosa superba* L. (Liliaceae), ("mondoliko"), with the rhizome containing a poisonous alcaloid. A single larva, 25 mm, was found in the stem.

Another larva, 20 mm, was collected in "kaeroet", the latin name of which plant could not be traced.

A portion of an *Amorphophallus* sp. (Araceae), was received at Bogor from Madiun, April, 1939. It harboured in the core the whitish caterpillar of *Hepialiscus* which pupated in a white felty cocoon speckled with dirt and yielded a moth (Dr. C. J. H. FRANSSEN).

The female which mated October 30—31 produced 467 black, granular eggs on November 1—2. They were kept in a humid atmosphere and hatched on November 15—18, the first stage larvae being 2 mm in size. Some 35 specimens were placed on November 20 in *Dioscorea* tubers which were punched previously. Four pupae developed after 6—8 weeks, one of which produced a moth. Some 100 first stage larvae were placed on *Manihot* roots for food, and several of them reached a size of 14—23 mm but none reached the pupal stage. The life cycle may take some three months only.

The larval galleries encircle the tubers and stems in *Dioscorea* and *Alocasia* and have a reddish colour.

The moths bred from early stages emerged in the field laboratory in the months January, February, July, August, and October. In two observed cases the moths emerged at 4 p.m.

*Palpifer sexnotatus* var. *ronin* Pfitz is recorded in Formosa to attack subterranean parts of *Colocasia antiquorum* var. *esculenta* and kill the plant (*Rev. Appl. Entom.* 1938 : 517). This record confirms the experience that particular hosts of *Hepialiscus* species are Monocotyledonous plants.

## Endoclita (Phassus) sericeus (Swinhoe)

In the course of forest entomological research in the environment of the field station at Gedangan a fairly known species of Hepialid collar-borer or ring-borer of various woody plants in Java and Sumatra was also found in the teak cultivations. In 1932—1934 some observations were made and experiments carried out in the field and in the laboratory to fill certain gaps in our knowledge of the species. A short life history of the borer, then called "*Phassus ?damor* Moore", was given in my handbook (1951). The moth has a rather variable wing pattern. It was

Text fig. 1. Moth of *Endoclita sericeus* Swinh. in resting position (after ROEPKE)

finally identified as *Endoclita sericeus*. A more complete account of the data on its life history is given below.

Rearing young larvae brought from the field in their tunnels appeared unsuccessful without special provisions. However, larvae of over 20 mm could be raised to moths when the roots of the host plant were kept in water. Some success was also obtained when medium sized larvae were moved from their tunnels to pieces of green *Manihot* roots, provided this material was changed at frequent intervals. The adults appeared to be nocturnal, resting during the day, hanging by the hairy front and middle legs from some projected part of a plant, the wings folded loosely round the body (text fig. 1); they resembled a withered leaf or a large hairy spider.

Copulation could not be induced in captivity, not even when the insects were released in a spacious cage in the forest. Accidentally a pair in copula was found elsewhere; the female hanging in the usual way from the tip of a leaf, the male resting in opposite position head downwards, with tips of the abdomens connected. The pair made the impression of a long crumpled dry leaf. But this was in a place far from the laboratory and no eggs could be secured. PHILLIPS (1938) described a similar mating of a *Phassus* species in Ceylon.

In Gedangan eggs were obtained in numbers on the bottom of the outdoor cage, well stocked with moths of both sexes. The eggs had the form of small, white granules soon turning black: however they did not hatch, apparently having been dropped by unfertilized females. So no larvae could be obtained at the laboratory from eggs. But, fortunately, very young larvae were discovered in the field, hiding in small tunnels, in dead, more or less rotten twigs, mostly of *Lantana*, among the litter near the forest border. These larvae were very slender, cream-coloured, 7—10 mm long and 1 mm broad. The entrance of their narrow tunnel was sealed off with faecal pellets and other tiny particles spun together. It may therefore be assumed that fertilized moths strew their eggs while swarming (as do other *Hepialidae*), and that the first stage larvae find shelter and food in dry twigs. This feeding of the borer in its earliest larval stage on saprophytic matter is an interesting feature in the ecology of the species.

Apparently the young larvae soon move to living plants in the immediate vicinity, burrowing in stems and stalks, 1—6 cm in diameter, near the collar of the plant, but not seldom also higher up. They bore a horizontal, circular or spiral gallery into the bark and sapwood, in addition to making a tunnel for hiding in the core, often downwards into the root or upwards in the stem or in both directions simultaneously. The ring-shaped feeding place is enveloped in close-spun silk, to the outside of which faecal pellets and particles severed from the bark are attached. The plant often reacts to the damage by growing a collar of wound tissue on the upperside of the circular wound, and this, in connection with the frequently puffy

web of the larva, may form a wide cuff around the base which may nevertheless remain inconspicuous due to its being covered with debris. During the day the larva hides in the tunnel, venturing outside its burrow at night to feed on the bark and callus and to repair or enlarge its web. It quickly withdraws into its tunnel on the slightest disturbance. Larvae removed from their shelter are very lively showing themselves particularly apt in moving backwards. At this stage the larva is greyish to blackish while the protrusions on the segments are of a lighter hue. The larvae are mainly characterized by a strongly sclerotized thoracic segment, provided with a deep pit (sense organ?) on each side. Growth is rapid according to observations in the field: the larvae reach 15—30 mm by March, 45—60 in May-June, and 50—75 mm in September-October, when they are 6—9 mm thick and ready to pupate.

Pupation takes place in the tunnel which is closed with a membrane resembling the web of a cavity-dwelling spider. The pupa is rough anteriorly while the abdominal segments have rings of small spines. When the moth is ready to hatch the pupa wriggles outwards until it projects halfway through the opening.

The emergence of the moth takes place in the afternoon and at dusk. About 4.30 p.m. the pupa may begin to move and show itself at the opening of the tunnel. It retreats immediately at the slightest alarm. When undisturbed, it takes the moth some 15—30 minutes to burst the pupal skin and free itself, soon taking the characteristic resting position. At 6.15—6.45 the moths start swarming. The appearance of the adults occurs from the end of October till mid February, most frequently in the month of December. Although the moths are not able to take any food, they can be kept alive indoors for 9 or even 12 days.

In rather thick stems of soft wood the wood is eaten away by the larvae near the entrance of the tunnel, a funnel-like cavity being formed, while in some cases in smaller plants the whole of the root base is destroyed. In plant species that have strong regenerative capacity (i.e., abundant callus formation), the circular incisions will be found at a considerable depth. The shelter tunnels may attain a maximum length of 35 cm but are usually shorter. A stem may be attacked by several larvae simultaneously (up to four have been observed in a *Crotalaria* stem, four cm in diameter) and in these cases the rings occur at some height above soil-level. On one occasion a gallery was observed 90 cm above the soil in a *Lantana* stem, 5½ cm thick. The borer rarely attacks trunks of big trees, but has been found in a *Schima noronhae*, 40 cm in diameter, 40 cm above the soil. It is possible, however, that the borer in these cases originally inhabited a creeper and later entered the trunk for the purpose of making a proper shelter tunnel.

The borer attempts its attacks apparently indiscriminately on a very great variety of plants in the field, but it depends on the properties of the hosts whether it can complete its life cycle. The borer does not reach the final stage if the tissues of the host are too hard to allow the excavation of a deep feeding gallery and good shelter tunnel or if the plant succumbs too rapidly as a result of the girdling. Saplings of *Altingia excelsa*, for instance, in West Java forest plantations, are often attacked but their bark is thin, the wound tissue too scanty, and the wood too hard. This species, therefore, is unsuitable as a host-plant of *Endoclita*. Full development of the borer has been observed in the teak area most frequently in *Lantana*, often

in saplings of teak (*Tectona*), occasionally in those of *Actinophora*, *Dillenia*, and *Macaranga*, and in several large shrubs as *Allophylus*, *Bridelia*, *Glochidion*, *Grewia*, *Leea*, and *Stachytarpheta*, as well as once in *Pandanus*. *Lantana* plants (*Lantana* was originally introduced into Indonesia from abroad but has since proliferated and now covers stretches of fallow land) appear to offer exceptionally good breeding places to *Endoclita*. Scores of larvae at different stages of development have been collected from *Lantana* stems in the neighbourhood of the field laboratory. Apparently abortive galleries of the borer have been found in the teak area in *Schleichera* and *Caesalpinia*. In reafforestations on the mountain slopes successful attacks of the ring-borer have been recorded in saplings of *Aleurites, Bischofia, Bixa, Glochidion*, *Trema,* and *Tristania* and along the skirts of the forest in *Eupatorium pallescens* and again in *Lantana camara.* Of the plants and trees on the estates and in native gardens *Cinchona*, *Crotalaria*, *Durio*, *Ricinus*, and cassava (*Manihot utilissima*) (Pl. 8 fig. 4) are suitable hosts. A successful infestation of the borer was once observed in a young *Jacaranda* tree in the Bogor Botanical Gardens. Typical traces of incomplete attacks by the ring-borer have been found in *Coffea* and *Thea* which are presumably unsuitable host-plants and in *Albizzia*, *Erythrina*, *Datura*, and *Rosa* which may indeed serve as true hosts.

No parasites of the borer have been observed and only very occasionally a predatory enemy, viz., woodpeckers. The main limiting factor against the spread of the borer may be that only a small percentage of the dispersed eggs fall in places conducive to development, while the very young larvae are exposed to numerous dangers as long as they are in search of a hiding place or host-plants and must be an easy prey for ants and other predatory species.

The best method of protecting young plantations against an invasion of the borer might be the removal of *Lantana* and *Eupatorium* thickets and accumulations of litter along their borders.

## 2. BIOLOGY OF INDO-MALAYAN COSSIDAE AND SQUAMURIDAE

### COSSIDAE

**Cossus subfuscus** (Snell., 1895). In an early publication of 1893, quoted by HEYNE (1950), it was stated that "peté" trees, *Parkia speciosa* (Leguminosae), suffer from borers and die prematurely when grown below 150 m altitude. This investigation had not been verified at the time, but in 1918 I observed that Cossid larvae were regularly found in peté trees at Bogor. They bore holes immediately under the outer flakes of the bark in the inner bark and sapwood. The same observation was made near Subah (East of Pekalongan) and, in 1923, in Purworedyo, Central Java. From the larvae at Bogor a few moths were bred which appeared to be identical with *"Trypanus" subfuscus* Snellen in the Leiden Museum (det. KALSHOVEN, 1921). In 1927 report was received from Purwakarta in West Java about die-back of peté trees. The insects submitted consisted in part of the reddish larvae of *Cossus,* in part of the larvae of *Xystrocera globosa*, a secondary Cerambycid. In June, 1940, the horticultural officer of Sidoardyo in East Java reported about the dying of peté trees, the bark of which had turned black as if scorched by fire. In a sample of damaged bark, again, *Cossus* larvae were found.

Most probably the borer will be present in peté trees in other parts of Java and elsewhere in Indonesia. However, its occurrence easily escapes attention. The bark of the trees is rather rough, and the larvae produce little frass. They appear, when small in number, not to affect the health of the trees. It may be that an abnormal increase of this number by causes still unknown has harmful effects and that in this case secondary borers, like longicorns, are attracted to the weakened trees and hasten the process.

C. pusillus Roepke, 1957. The original data on the labels of ROEPKE's paratypes, not quoted by him, indicate that the moth borer was found in the trunk of *Diospyros kaki* (Ebenaceae) ("batang kesemek") near Garut, at 800 m, in West Java, Aug., 1926.

**Zeuzera indica** Herrich-Schäffer, 1854 (syn.: *Z. postexcisa* Snell., 1900 nec Hamps.). ROEPKE (1957) has cited my first discovery of the larva of this large species in galleries at the base of a huge *Phoebe excelsa* (Lauraceae) ("huru leuheur"), in virgin forest on the South slope of Mt. Gedé, 1000 m, West Java (KALSHOVEN, 1919). This find should be dated Tjiparai, January, 1917. Since then the occurrence of the borer in Lauraceous trees has been noticed several times, as shown by the following field notes.

March, 1921, a specimen of the moth bred from a "sintok" (*Cinnamomum* species, particularly *C. burmanni* and *C. iners*) found in a 5-year old forest plantation at Tjiguha, Djampang District, West Java. — June, 1922, a specimen of the borer found in "adem ati" (*Litsea chinensis*) collected in the teak forest of Padas, Semarang District, Central Java. The moth emerged in August. — November, 1923. A consignment of borer-infested material, received from Rambipudyi, Besuki, East Java, included a portion of a "buru semut" (Lauraceous tree) containing several galleries. A Cossid larva still present among the frass, soon succumbed. — October, 1930. Five larvae collected from *Litsea chinensis* trees in the teak forest of Manggar, Semarang district. Only a single malformed pupa was obtained from the material. — 1932. During extensive investigations of Cossid borers by the Javanese personnel of the field station at Gedangan some 40 infestations of *Z. indica* in *Cinnamomum* trees ("sintok") and 80 in *Litsea chinensis* ("adem ati") were collected; several moths were bred. — July, 1953. An infested "huru manuk" (Lauraceous tree) found in a neglected plantation near Leles, East Priangan, West Java. The large faecal pellets were similar to those of *Z. indica* (see below).

These records show that the species is more common in Java than ROEPKE assumed. Presumably it is equally common in Malaya and Sumatra. In a paper by RIDLEY (1896 : 116) I found the note: "The chief enemy of cinnamoms here [in Malaya] is a very common borer, a red caterpillar which burrows into the stem. It attacks ... chiefly ... the wood of full grown trees". In a study of the forest flora of Sumatra F. H. ENDERT (1925, *Tectona* 18) mentions that large larvae make tunnels in the trunks of Lauraceae in Simelungun and the Karo Lands, causing much trouble when one tries to exploit the timber which often is of good quality in other respects.

The caterpillar is reddish-purple with dark spots (small chitinous disks) on the dorsal side, the ventral side being yellow-white; a dark streak along the front of the pronotal shield broadening at the corners; up to 6 cm in length and 12 mm broad. Sometimes the larva gives off a distinct sourish smell.

Among the hosts observed in the teak woods at Gedangan only *young* "sintok" and "adem ati" trees could be found. The borer's presence could be detected by accumulations of round and coarse faecal pellets (Pl. 7 fig. 2), up to 7 mm in diameter and composed of undigested wood particles, between the buttresses of the infested tree. There is a round hole in the base of the trunk 1—10 cm above the soil, where the trunk of young "sintok" is 10—35 cm, that of young "adem ati" 6—30 cm. The hole leads to tunnels of different dimensions in the trunk and in the main roots, the former sometimes ascending close to one another in which case they probably have been made by one and the same borer specimen at different periods of its development. The total length of the tunnels amounts to several decimeters. The wall of new sections is brown or reddish; that of older sections is black. These particulars differ considerably from those given by BEESON (1941) for the galleries of *Z. indica* in *Litsea polyantha* in India which are alleged to resemble the tunnels of a *Xyleutes* species.

The ejection of faecal pellets, numbering 10—20 daily, is carried out rather regularly. The pellets disintegrate during rainy weather; the saw dust accumulations are soon hollowed out from below by termites. When the ejection of pellets ceases this may be the sign that the larva is preparing for pupation; it then bores a new hole to the outside which is situated immediately above the old hole and is kept closed by a thin outer layer of bark. Pupation takes place behind a protective web.

Larvae of varying size have been found in one and the same tree, and nearly mature specimens or pupae at different seasons of the year, though they were more numerous in the period of February to April. The latter fact, however, may be due to a particularly extensive search during this period, and no well-defined periodicity has become apparent in the borer's development. When exposed in its gallery the larva starts to close the opening with silk.

The pupal stage lasts for 4 to 5 weeks, the moths emerging in the afternoon between 1 p.m. and 7 p.m. The males are not attracted by the females at any great distance. The life cycle is estimated to last at least one year.

Wood peckers succeeded in extracting the borer in only four out of some 80 infestations observed in "adem ati" trees; no traces of their activities were found in the borer attack on "sintok". It happens far more frequently that, apparently without reason, the ejection of pellets ceases from a hole, originally inhabited. After having been opened these galleries proved to be empty or contained only the remnants of a dead larva or pupa. Once a predatory ant (*Pheidole* sp.) was found in an abandoned tunnel. Termites had entered the gallery in many cases and filled it with soil. It is very doubtful, however, whether the termites do any harm to the borer, no matter how readily they enter holes in the trunks, especially those close to the ground. The attempts to breed the moth in the field laboratory from infested parts of the holes inhabited by a mature borer and planted in containers and kept moist, were often unsuccessful and only produced a dead or malformed pupa. The pupal stage, apparently is rather vulnerable.

Z. coffeae virens Toxopeus, 1948. In my papers of 1919 and 1940 I have elaborated on the habits and life history of the "red branch borer". There only remains to give an additional list of its foodplants and to compile the notes on its diseases and parasites.

Alphabetical list of hosts observed in the years 1920—1940

*Acalypha hispida*
*Albizzia procera*
*Annona muricata*
*Antidesma bunius*
*Bixa orellana*
*Bridelia* sp.
*Brucea amarissima*
*Cassia fistula*
*Ceiba pentandra*
*Citrus* sp.
*Crotalaria anagyroides*
*Derris macacranta*
*Eugenia* sp. ("djambu")
*Gossypium obtusifolium*
*Graptophyllum pictum*
*Hibiscus cannabinus*
*Hibiscus rosasinensis*
*Hydnocarpus wightiana**)
*Indigofera suffruticosa*
*Lantana camara*
*Mallotus repandus*
*Manihot utilissima*
*Olax scandens*
*Peronema canescens*
*Persea gratissima*
*Psidium guajava*
*Pterospermum* sp.
*Santalum album*
*Stachytarpheta mutabilis*
*Swietenia macrophylla*
*Thespesia lampas*

*) recorded for Malaya by MILLER (1941)

With 20 names mentioned in an earlier publication (KALSHOVEN, 1919) this sums up to 50 host plants found in Java. BEESON (1941) has listed 38 foodplants of the species for India.

A small detail in the habits of the borer, so far unpublished, is that the young larva sometimes starts boring in a leaf petiole, soon to move to a better suited place in the stem. This has been observed in *Swietenia mahagoni* and *Cassia siamea*. The larva may leave its gallery also in later stages, in search of better conditions.

Very little has been published on the diseases and enemies of the red branch borer. A fungus found on a larva, collected on an estate on Mt. Klut, East Java, has been identified by BOEDIJN as *Beauveria densa* or *basiana* (ANONYMOUS, 1933). A few parasitic wasps and a Tachinid have been observed with *Zeuzera* but only a somewhat conspicuous yellow Braconid, *Glyptomorpha* sp. (cf. MILLER, 1941), has been named. There was a picture of it on a colour plate by LEEFMANS (1916) but no name was given. Not infrequently the borer is pecked out by woodpeckers.

*Zeuzera* sp. Many times a borer infestation has been observed in saplings of *Cassia siamea*, of 5—12 cm in diameter and up to 6 m in height, growing in forest cultivations in various localities of Central and East Java. The infestation is conspicuous only in an advanced stage, when the trunks show annular swellings at various heights (Pl. 8, fig. 2). These swellings appear to have been caused by the overgrowing of horizontal tunnels encircling the trunks more or less completely. In recent infestations small holes are found along the trunks from which a black sap oozes and stains the bark. These holes correspond with horizontal galleries

immediately under the bark; they are a few mm high and 9—12 cm long and are excavated on one side or both sides of the hole. Often a red caterpillar of at most 2.5 cm is found which closely resembles a *Zeuzera* larva. The black stain covers a few square cm around the hole and can extend downwards over a few dm. All these borings appear to be stopped prematurely due to the death of the larva, this possibly being caused by the sap flow or a too rapid overgrowing of the entrance hole. As the larva of *Zeuzera coffeae virens* has the habit of forming a ring in the cambial zone and of further developing in the dying top part of a stem, the infestations described may be explained as to be abortive attacks of this species.

**Z. roricyanea** Walker, 1861. TOXOPEUS in his study of *Zeuzera* material in the collections at Bogor (1948) came to the conclusion that two species had been confounded when reference was made to a "red branch borer" in Java, regularly identified with *Zeuzera coffeae* Nietn. The apparently common polyphagous species found in small stems and branches he considered to be a subspecies (*virens* ssp.n.) of the South Asiatic *Z. coffeae* Nietner, 1861, originally found in Ceylon. The second apparently much rarer species TOXOPEUS identified as *Z. roricyanea* Walk., described from specimens collected in Sarawak, 1861, and also found in Kutei, S.E. Borneo. The biological note with regard to the latter species reads: "Reared from putat (*Barringtonia* sp.) and balsa (*Ochroma lagopus*) in Central and West Java." These particulars are based on material obtained during my forest entomological investigations. A few additional remarks should be made, now, taken from original field notes.

"Putat" is a collective name for Lecythidaceous trees, particularly *Barringtonia spicata* and *Planchonia valida*, not seldom growing wild in the teak woods in Central Java and reaching a height of 18 m and 50 m, respectively. The borer material seen by TOXOPEUS had been reared by Indonesian personnel from trunks of "putat" trees, 8—30 cm in diameter at breast height in the neighbourhood of the Gedangan field station. The moths emerged between the end of October and the beginning of March. The pupal stage lasted at least 20 days. An experiment to attract male moths from the surrounding forest to female specimens kept in outdoor gauze cages failed to give any evidence of such an attraction as has been so commonly observed in *Zeuzera coffeae virens* and in *Xyleutes* species (KALSHOVEN, 1934, 1940).

The following borer infestations also attributable to *Z. roricyanea* have been observed at Gedangan. (1) In young trees of *Melochia umbellata*, Euphorbiaceae, up to 12 cm in diameter; infestations near the base and higher up; sometimes a distinct swelling apparently caused by annular subcortical galleries; in other cases irregular ascending tunnels generally overgrown and marked by a prolific growth of callus tissue. (2) In a young tree of *Bauhinia malabarica,* Leguminosae, 25 cm in diameter; galleries in the woodlayers at three places of the trunk. (3) In a young *Eugenia polyantha,* Myrtaceae; an ascending tunnel of 35 cm; no horizontal annular section. These three cases refer to Gedangan, Central Java. (4) In a three year old plantation of *Casuarina equisetifolia*, Casuarinaceae, in Deli, East Coast of Sumatra; stems with ring-like galleries at various heights where the saplings were 4—8 cm thick; in some plots every tree was infested, often the tops died off a

few meters downwards or had broken off at a point coinciding with an annular gallery.

The infestation by *Z. roricyanea* of 1½ year old, vigorous *Ochroma lagopus* trees in the garden of the Forest Research Institute at Bogor in 1950—1951 has been described in some detail by VAN ALPHEN DE VEER & SUDIRO (1951), as due to "*Zeuzera coffeae*". The infestation occurred all over the trunks averaging 14 cm in diameter, and in the branches. Several trees showed swellings caused by the overgrowing of former galleries. Circular galleries right under the bark had caused the breaking off of top parts.

A similar attack had occurred in 1936—1937 in a newly started plantation of *Ochroma* in an estate in Bantam, West Java. The galleries had a horizontal section in the inner bark and cambial zone cutting through the outer wood layers while the rest of the tunnel was directed obliquely upwards but continued to run close under the bark, without killing the trees (Pl. 7 fig. 1).

VAN ALPHEN DE VEER and SUDIRO observed "the same borer" in the experimental garden at Bogor in young specimens of *Khaya anthotheca, Cedrela mexicana* and *Eucalyptus deglupta.* However, as they were unaware of the mixing up of two species of *Zeuzera* (red branch-borer) in Java it remains doubtful whether these three species of trees have to be listed as hosts of *roricyanea* or of *coffeae virens.* Both borer species may occur side by side in the same area in West and Central Java.

TOXOPEUS (l.c.) attributed an attack on cocoa trees (*Theobroma cacao*) recorded in 1900 to *roricyanea* and not to *coffeae.* If true, this fact must have escaped the attention of ROEPKE, though he made an extensive study of the borers of the cocoa trees in Central Java and had the collection of the Experiment Station at Salatiga at his disposal.*)

The above observations show that *roricyanea* is less common in the plains and lower hills of Java and is more selective in its choice of food plants than is *Z. coffeae virens.* For the rest TOXOPEUS' conclusion that "the distribution of this species (*roricyanea*) and the damage caused by it have been studied far from satisfactorily" is still valid.

**Xyleutes strix strix** L. is a large borer of *Sesbania grandiflora* (Leguminosae) ("turi" tree). Observations on its life history made at the Gedangan field station date from 1933.

The larvae bore tunnels into the wood of the base of trees of 4—20 cm in diameter. The tunnels extend downwards into the roots or upwards in the stem over a length of 10—25 cm. The base of the trunk becomes swollen and the bark is rough in consequence of the borer's activities. Young larvae are wine-red (resembling *Zeuzera* larvae), turning purplish later on and finally becoming yellowish or creamy. When full grown they are 7.5—8 cm. The larvae have been reared in the laboratory from the first instar to half grown specimens on "turi"

*) A minor error in TOXOPEUS' paper may be rectified here. He supposed that the "kola" plant mentioned by ROEPKE among the host plants of the red branch borer most probably was "coca". In fact the African Kola nut, *Cola nitida*, Sterculiaceae, was grown in those years on a small scale in the Experimental Garden at Salatiga.

twigs, frequently replaced, then moved to fresh *Manihot* roots, in which they bored readily and matured. Before pupation a close and strong cocoon is spun. The pupa rests in a gallery leading to the surface of the stem at about 10 cm above the ground. Before emergence the pupa forces its way outwards until it projects from the hole with the front half. After the moth has left, the empty skin remains sticking in the hole for a long time. The moths swarm in the months of November-January; they often appear in the afternoon. The females are rather sluggish, their abdomens being filled with countless eggs; they attract the males during the night; copulation may continue until 5 o'clock of the next afternoon. Shortly after pairing the female deposits the eggs in very large yellowish clusters (Pl. 9 fig. 1, 2). The development of first instar larvae and their dispersal is rather similar to what has become known of *Xyleutes ceramica* (cf. KALSHOVEN, 1934). The egg mass turns greyish on the 6th—8th day due to larvae leaving the egg shell and immediately starting to spin threads. Soon the cluster turns into a teeming mass of tiny larvae in a communal webbing. On the 12th—15th day the larvae leave the web and disperse over the plant or substrate constantly spinning. They move to projecting places like margins of leaves where they lower themselves on the fragile threads a short distance, dangling with the wind and lengthening the thread at each stronger puff of air. Where numerous suspended larvae are close together their parallel threads appear like a flimsy curtain. Ultimately the threads break and the larvae are carried with them and float in the air. When caught too soon by some neighbouring object they climb it and repeat the procedure of lowering themselves and being exposed to the wind until they finally break away and disappear into the air. Only a small fraction of the thousands of larvae will alight on or near a host plant and succeed in establishing themselves. This way of dispersal reminds one of that of air-borne seeds.

The total life cycle of the borer takes about a year.

Once the borer has been found in the root of a "kara" plant (probably *Dolichos lablab*, Leguminosae). The "turi" trees seem to sustain no distinct injury from a slight to moderate infestation. As the twigs and leaves are only used for fodder, the borer has hardly any economic significance.

**X. persona** Le Guill. 1841. ROEPKE (l.c.) has synonymized this species with *Duomitus leuconotus* auct. Under the latter name it is mentioned by several British authors as a borer in *Cassia* spp. in Ceylon, India and Burma (STEBBING, 1914, T. B. FLETCHER & GOSH, 1920, ANONYMOUS, 1923, MACKENZIE, 1923, GARTHWAITE, 1938, by this author as *Xyleutes persona*, and GARDNER, 1948). In the collection of the Instituut voor Plantenziekten at Bogor L. J. TOXOPEUS found a small male specimen with a host label *Cassia* sp. (handwritten note, dd. 21 June 1943; unfortunately no species name of *Cassia* is given). This seemingly confirms the association of the species with *Cassia* trees. However, DUPONT bred the moth from five almost full grown larvae and four pupae found in the base of a felled *Durio* tree at Bogor (1937). C. J. H. FRANSSEN (i.l.) observed several infested young trees of *Durio* ("durian") in the same locality, in January, 1957. These trees, mostly up to 10 cm in diameter, had large holes mainly in the basal parts but sometimes higher in the trunk, from which holes frass was expelled and sap

oozed. The largest holes measured 6 cm in length and 2.5 cm in width. Presumably the larva was a cambium and callus feeder. "Durian" trees in villages around Bogor appeared to harbour the borer rather frequently. Young trees may suffer to some extent, showing die-back of branches, but old trunks do not.

It is surprising that one and the same species of *Xyleutes*, which genus usually displays a certain selectivity, should live in trees botanically so different as *Cassia* (Leguminosae) and *Durio* (Bombacaceae). It is also curious that no Cossid borer has been found during extensive forest entomological investigations in Central Java, either in *Cassia fistula* or in *C. javanica*, trees not seldom grown in plantations and parcs. Therefore a further study of this discrepancy may be recommended.

HOULBERT (1916) assigned *leuconotus* Walk. to his genus *Melanostrigus*; he does not mention *persona* Le Guill. GARDNER (1948) writes: "it is doubtful whether *leuconota* is a synonym of *persona* LeG.".

**X. ceramica ceramica** Walk. 1865. BEEKMAN (1919) gave a detailed description of the holes of this borer in teak trees of diverse age in the forests in Java. In 1932 extensive investigations and experiments were started in the field station at Gedangan to further study the habits of the borer. Some success was achieved in breeding the moth ab ovo or from young larvae, in the laboratory as well as in living trees. The working out of the numerous data obtained is still unfinished, but a short communication on the main habits concerning copulation, oviposition and dispersal of first instar larvae was published by me in 1934 (in Dutch). British and Indian forest entomologists have contributed much to the knowledge and incidence of the borer in India and Burma. An extract of these data comprises some 8 pages in BEESON's handbook (1941).

DE MESA (1933) published a short note on the discovery of the borer in teak in the Philippines, where this tree has been introduced. He specifies that the larvae had been found in the branches of a large tree. In Java and India the borer lives in the trunk. The full grown larva is said by DE MESA to be "satiny white in colour", while in the countries just mentioned it is banded transversely with pink and white on each abdominal segment (BEEKMAN 1919, BEESON 1941).

ROEPKE (l.c.) records that the distribution area of the species includes New Guinea. In this connection it is interesting that a young plantation of teak in the Western part of the island appeared to be infested very soon after the experiment had been started. (Correspondence on this matter is in the 1956 files at the Tropical Institute, Amsterdam.)

From notes on host plants, so far available, it is clear that the borer is restricted in its occurrence to species of Verbenaceae all over the Far East, viz., *Gmelina arborea, Premna* sp., *Tectona grandis* and *Vitex pubescens*.

Woodpeckers as enemies of the borer have been known for a long time (BEEKMAN, 1919). In Bandjar, West Java, large squirrels (*?Ratupha bicolor*) were able to open the hiding tunnel of the borer in young teak trees, gnawing away the sap wood and causing large wounds (Pl. 9 fig. 3).

**X. mineus mineus** Cramer, 1775. The Indonesian name for the host plant of this borer in the teak area of Central Java mostly is "ri bandil" but, in a

few cases, has been mentioned as "setjang". Both names are used for thorny semi-climbers or shrubs. In the botanical literature the first name has been used for *Zizyphus oenoplia*, an uncommon plant of the Rhamnaceae (KOORDERS, Exkursionsflora, 1912). The second name indicates *Caesalpinia sappan*, Leguminosae, often grown in hedges. Presumably the latter identification of the host plant is the correct one.

The infestation occurs at the root collar of the stems which are 2—10 cm in diameter. Most galleries, up to 35 cm in length, run downards into the roots, some upwards. The larvae are yellowish with violet cross bands and dark spots on the abdomen.

The moths emerged from forest material in August-January. The behaviour of the species during the short adult stage and the dispersal of the young larvae were rather similar to those of the preceding species. The male moths became active at dusk (6.30 p.m.), vibrating their wings with a buzzing sound. A male specimen fixed by a cotton thread tried to fly away at this hour during four successive days. The females were more stationary and sometimes attracted a male from the surrounding forest during the night. Soon after copulation the females produced large egg clusters which turned reddish and began to hatch after about a fortnight. Experiments at the Gedangan field station in order to raise the borer from first instar larvae had little success (1932, 1933). During the first six months the larvae were given fresh twigs of the host. When they had reached a size of a few cm they were moved to *Manihot* roots. Development was slow and mortality very high. After a year from a hundred larvae only a small number of pupae had been obtained and several of these did not hatch. Ultimately only a few moths, most of them males, emerged, one year and two to seven months after the eggs had been laid.

**X. maculata** (Snellen, 1879). SNELLEN added to his description that, according to this collaborator PIEPERS, the larva presumably lives in Celebes in *Canarium commune* (Burseraceae). In Java the moth has been bred from a twig of cotton tree, *Ceiba pentandra* (ROEPKE l.c.).

**Phragmataecia gummata** Swinhoe, 1892 and *Ph. sumatrensis* Snellen, 1880. ROEPKE (l.c.) explains that a much longer morphological study is necessary for a satisfactory separation of the *Phragmataecia* species described from the Far East. As for the host plants he expresses his "strong conviction that the giant grass, *Saccharum spontaneum* ("kasur" or "glagah"), is the foodplant" and he quotes my notes on the occurrence of the borer in sugar-cane, *Saccharum officinarum* (KALSHOVEN, 1951). In fact a *Phragmataecia* had already been reported from *Saccharum spontaneum* in India in 1920 (FLETCHER & GOSH). For Java the sugar-cane borer has been listed and figured by ZEHNTNER in 1897 (p. 488; copied in VAN DEVENTER's Pests of Sugar-Cane, 1906). It was called the "Bandung borer" having been found in nursery fields for sugar-cane near Bandung, West Java, but not in the extensive sugar-cane plantations of Central and East Java. In 1925 the borer occurred in large numbers in an experimental plantation of sugar-cane in Deli, Sumatra's East Coast (VAN HALL, 1926).

In September, 1928, it was reported from the government selection gardens at Fort de Kock (± 1000 m, West Sumatra), the species being identified in this case as *Ph. parvipuncta* Hamps. at the British Museum, London (det. BRYANT). The borer was rather injurious to native sugar-cane fields at Padang Pandjang (W. Sumatra) in 1936 (KALSHOVEN, 1950 : 364). Under the name *Ph. castaneae* Hb. the borer has been reported repeatedly from sugar-cane in Malaya (*Rev. Appl. Entom.* 1924 : 36, 379 ; 1925 : 550). A *Phragmataecia* moth has been caught at lamplight at the Gedangan field station in the months February, April, September, and November. This is an indication that the larva finds a common breeding place in wild *Saccharum* on the borders and in the ravines of the teak woods.

T. B. FLETCHER & GOSH (Borers in sugarcane etc. in India, 1920) mentioned a "purple coloured Zeuzerid borer" in *Saccharum arundinaceum* (= *Erianthus arundinaceus*) and a "violet-spotted Zeuzerid borer (*? Phragmataecia* sp.)" in *Saccharum spontaneum* and *Andropogon sorghum*. They gave notes on the life history of the latter species and fine drawings of the larva, pupa and adult. Unfortunately ROEPKE has overlooked these data in the "Pusa Proceedings".

Cossid in *Ceriops*. A branch of *Ceriops* (Rhizophoraceae; a regular constituant of the coastal vegetation) tunneled by a borer, was collected on a small island of the tidal forest reservation Angké, North of Djakarta, in November, 1935. The larva proved to belong to the *Cossidae*. An attempt to breed the moth failed. Neither the specific host plant, nor the peculiar habitat give any clue to the possible identity of the borer.

## SQUAMURIDAE (= Arbelidae, Indarbelidae)

This family is well represented in the Indomalayan region. ROEPKE (l.c.) stresses the fact that "a sharp discrimination between the species, at present, remains difficult".

**Squamura maculata** Heylaerts, 1890, is a very common species in the plains and lower hills of Java, attracting the attention by the cord-like webbings its larvae make on the bole and main branches of trees (Pl. 9 fig. 4). The larvae have the habit to loosen the rather narrow web in the beginning of the night and to shift it to an adjacent part of the bark on which they feed. They abrase only the epidermis and superficial tissues, going not deeper than 3—4 mm. Only the soft tissues are eaten, thick fibres and sklerenchym cells are left alone and become prominent. The marks and patterns are inconspicuous and do little or no harm to the tree. The activity of the larvae can be watched easily at night, using a lamp, as the web under which they work is transparant. At the slightest disturbance the larva immediately retreats in its hole. The moths do not become active until darkness. The males are attracted to the females; copulation has been observed between 9 and 10 p.m. Repeated experiments to rear the moth ab ovo in the Gedangan field laboratory proved successful only in a few isolated cases when fresh twigs of *Ceiba* were used as food. Total development required about a year.

ROEPKE mentions the cotton tree (*Ceiba*), two Leguminosae and four fruit trees as hosts. To these should be added *Erythrina*, *Cassia siamea*, and *Pithecolobium lobatum* as very common hosts but the list of occasional hosts could be extended

almost indefinitely. Apparently tree species with a smooth bark are most suitable. It is also interesting that more or less isolated trees are often selected, but not trees growing under the canopy of woods and groves. Perhaps the outer bark tissues are less nutritious in the latter case (lacking sufficient chlorophyl ?).

FRANSSEN (1941) mentions several additional fruit trees as hosts and reports on a very harmful occurrence of the borer in neglected *Citrus* gardens in the neighbourhood of Malang, East Java. A similar case was reported in 1914 (ANONYMOUS) in *Citrus* gardens at Punten, Mt. Ardjuno, East Java, in which instance many branches had died. This kind of damage, also described by FRANSSEN, much resembles that of *Sq. acutistriata* (see below); perhaps it was a mixed infestation in which more than one species of *Squamura* was involved. ROEPKE did not cite FRANSSEN but he recorded the breeding of an adult of *Sq. magma* de Joannis, 1921, from the bark and stem of *Citrus* (Bogor, June, 1953, TJOA TJIEN MO).

**Sq. flavina** Mell, 1923 is closely related to the preceding species and is numerous in the mountains of Java between 1000 and 1800 m (ROEPKE, 1957). Its habits appear to be similar to those of *maculata*.

**Sq. celebensis** Roepke, 1957. The single specimen on which ROEPKE founded his new species was reared from a branch of a cotton tree (*Ceiba pentandra*, Bombacaceae), Makassar, January, 1948, C. FRANSSEN. In December, 1939, a severe infestation of branches, particularly old branches, of old cotton trees was reported from South Celebes. The material submitted contained a reddish Cossid-like larva. No further material was investigated, but as the damage resembled that caused by a *Squamura* species (cf. *Sq. acutistriata*) it would not be too far-fetched to ascribe the injury to *Sq. celebensis*, the only known *Squamura* species recorded from Celebes in ROEPKE's monograph.

**Sq. acutistriata** (Mell, 1923). In contrast with *Sq. maculata* this species mainly lives in the crowns of trees, the branches of which are often short, bent and gnarled. Several observations were made on its occurrence in the crowns of "kedinding" trees (*Albizzia lebbeck*, Leguminosae) in the area near the field station at Gedangan. The larvae gnaw rather deeply, viz., 3—5 mm, into the bark of twigs and small branches, always under cover of a web, causing severe lesions and often the death of top parts. The dry wood of snags is also eaten. Repeated activity of the borer renders the tree tops gradually more suitable for breeding and the limbs become covered with scars.

Mature larvae are 30—32 mm; these larvae as well as pupae have been found in the beginning of September. The moths continued to appear until the first week of October, emerging mostly between 5 and 7 p.m. in the laboratory. Female moths, kept in a gauze cage outdoors, attracted the males from the environment several times. They appeared between 3 and 9 p.m., once even three specimens at the same time. When the door of the cage was opened they readily entered; copulation soon followed and was of short duration. Next day the eggs were laid in clusters stuck together by means of a slimy substance. When fresh they are isabella coloured, turning brown on the 5th day and hatching on the 10th day.

Rearing the moth in the laboratory succeeded only three times with young "kedinding" branches as food. The development required about one year.

DOCTERS VAN LEEUWEN (1910) described the injury of the species to cocoa trees (*Theobroma cacao*) in estates in Central Java.

Sq. **tenera** Roepke, 1957. The holotype, a male, was reared at Gedangan from a greyish larva, 20 mm, found in a horizontal annular gallery at 1 m above the soil, therefore rather low for a *Squamura,* on a teak sapling, 28 February, 1933. The method of feeding and webbing reminded of that of the rootcollar borer, *Endoclita sericeus*, but its behaviour and habitus were different. The larva had two large dorsal sclerotized plates on each segment with a slight dent between. It was placed for boring and feeding on fresh *Manihot* root, which was substituted by a new piece every 10—14 days; 29 August the larva pupated; during the night of 22/23 September the moth emerged.

## DISCUSSION OF THE HABITS AND HOSTS OF INDOMALAYAN COSSIDAE AND SQUAMURIDAE

There occur *Xyleutes* species feeding on the nutritive cambial and callus tissue of a living trunk, while hiding and pupating in a short tunnel, which may be excavated in the heart-wood of old trunks and in the pith of saplings. *X. anceps* Snell. causes gall-like swellings in branches of *Derris* sp. (KALSHOVEN, 1950). Apparently several *Xyleutes* species live in the crowns of trees, but this group is still very insufficiently known. Some *Xyleutes* species are associated with certain plant families (Verbenaceae for *X. ceramica*) or genera (*Cassia* and *Durio* for *X. persona*) or even species (*Sesbania grandiflora* for *X. strix*).

*Zeuzera* larvae feed entirely on wood, having to digest large quantities and therefore to make long galleries. In *Z. indica* the galleries are excavated in the living wood of the trunk of Lauraceae. In *Z. coffeae* the larvae are only able to live in stems and twigs of small dimensions; after entering the stem the larvae bore a circular tunnel and thereby intersect the sapflow; they have their main development in the dying and dry top part of the stem (Pl. 8 fig. 1). The latter species appears to be most specialized in its boring technique, but not in the choice of its host plants. *Z. roricyanea* is intermediate between the two other species.

*Phragmataecia* species are exclusively associated with tall grasses like *Saccharum*, *Sorghum* and the like. As is shown in other Lepidopterous families, feeding on Graminaceae apparently requires special adaptation as it is met with only in a limited number of genera and species (cf. the *Phragmites* fauna in Europe). That a genus of the usually wood-boring *Cossidae* has become adapted to living in graminaceous stalks may be explained by supposing that the Cossid larvae possess the capacity to break down cellulose, an indigestible substance for most animals with the exception of several insect groups that live with particular symbionts.

In the *Squamuridae* the feeding on wood is much reduced. In boring their shelter tunnels the larvae often penetrate into old snags, wounds and rotten parts, or they simply inhabit a groove at the place of forking of the trunk and similar spots. A peculiarity of the larvae is that they construct extensive webbings, starting from the entrance hole of the tunnel and covering the portion of bark or wood on which

they feed. On the outside the web is covered with excrements and severed particles. In *Sq. acutistriata* the feeding on wood appears to be less reduced than in *Sq. maculata* and allied species. GARDNER (1948) has pointed to the resemblance in the habits of larvae of *Squamuridae* and *Hepialidae* which both feed in soft external tissues of the stem under a camouflage of frass and silk with a deeper tunnel for refuge. This resemblance is particularly striking in *Sq. tenera.*

## 3. TWO PYRALID BORERS OF BAMBOO

A peculiar kind of damage noticeable in bamboo groves in West Java consists of a series of diseased internodes at some height of the culms; these internodes are shortened and malformed and show several slits and clefts in the cylindrical wall (Pl. 10 fig. 6). KONINGSBERGER in his "Java zoologisch en biologisch" (1915) drew attention to this defect. He found a large number of flesh-coloured larvae, with a tough skin, and sometimes pupae, in the lowest part of the affected portion of the culm. These insects appeared to be well-known to the native population; they were called "tjangkilung" and were used for fishing bait. KONINGSBERGER could not explain on what tissues the larvae feed and how the moths escape from the sound internode in which they hatch. He recognized the moth as a Pyralid (although not attracted to lamplight), and emphasized the need for further investigation.

This further study was undertaken in 1940 by Dr. P. A. BLIJDORP and his Javanese assistant MAS SUDIRO, of the Instituut voor Plantenziekten at Bogor. KONINGSBERGER's conclusion about the kind of borer causing the malformation was soon confirmed. In Central Java a different Pyralid appeared to occur in bamboo culms. Owing to the Pacific War and the Japanese invasion, the work in the field and in the laboratory was left to Mr. SUDIRO and his native helpers. After the war, when I was working on a survey of the pests of Indonesian crops, I found a file containing field notes in Indonesian, tabulations and drawings, compiled during the foresaid investigations, carried out with much diligence during the years 1941—1944. Material of the moths was sent by me to the British Museum of Natural History in London. The identifications by the well-known lepidopterist, Mr. W. H. T. TAMS, were received in 1951, but publication of the notes has been delayed. Though a coherent record of the observations is not at hand, the data compiled by the Indonesian personnel point to various most interesting features in the biology of the borers. An extract covering the main points is presented here.

**Chilo fuscidentalis** Hampson, is the West Javanese species with brown markings, wing expanse 40—45 mm (Pl. 6 fig. 1—2). This is essentially a borer of sprouting bamboo. Sprouts of new culms begin to appear in bamboo groves in West Java in October. They grow fast in height, reaching a length of 25—100 cm in a month. By this time their top is crowned by a thick bunch of bracteae, which is shed afterwards. At the end of the month of December the sprouts may be 150—250 cm high. The *Chilo* moths swarm in the period November—January and lay characteristic flat batches of eggs, free from hairs or scales, on the sprouts, about half way to the top (Pl. 6 fig. 7—9, Pl. 10 fig. 1). They contain 40—140 eggs (90

on an average) which are arranged imbricately. When hatching after 12—13 days the slender larvae, 2.5—2.75 mm in size, begin to move upwards in a file. They are in search of a spot suited for boring into the tissue. Three to five of the foremost individuals select the spot and begin the boring which may be at a distance of 100—200 cm above the batch of egg shells. The group acts gregariously, the larvae of the "shock troop" are replaced by new individuals which take their turn in deepening the entrance, the other larvae milling and resting around (Pl. 10 fig. 2, 3). Soon the roundish hole, 1.75—2.75 mm in diameter, is deep enough and the larvae disappear into it. Extrusion of a milky fluid from the hole indicates that inner tissues are reached. The whole process takes less than 24 hours. Often, after 2—5 weeks, a curious T-shaped hole leading outwards, appears in a sound joint beneath the cap, but more results of the activities of the larvae come into evidence after the cap of dry bracteae is shed. It then appears that a series of 8—10 newly formed joints below the top of the sprout which were in process of lengthening and hardening, are stunted and show window-like slits. Moreover, in some cases it appears that a round hole of 9 mm in diameter and closed with silk has been made in one of the sound joints beneath the affected part. The T-hole is widened by the larvae occasionally, but keeps the same shape (Pl. 10 fig. 5). From this hole, sometimes, substantial quantities of dirty coloured liquid are discharged. As a rule the top of the sprout keeps growing and forming normal joints, but it has been observed in several cases that the part formed after the borer-invasion looks thinner than normal; seldom the top withers. All this takes place between the months January-September. In two cases where the infested parts of the culm had to be opened early, the larvae had grown to 24—26 mm in length and 4—6 mm in width in a period of 9—12 weeks.

When undisturbed, the larvae, then 30—31 mm in size and apparently fully developed, begin to assemble in September, in a sound joint of the culm, just above the joint with the T-opening, that is, 2—5 joints below the damaged section (Pl. 10 fig. 4). The larvae reach these joints via roundish holes which have been bored through several sound partitions; these holes are closed by silk afterwards. The mature larvae keep moving for some time and appear to abrase from the inner wall of the joint the powdery substance which is present in normal joints. Ultimately they settle on the ceiling of the internode selected where they attach themselves with the cremaster and pupate in a hanging position (Pl. 6 fig. 10). This, again, is a gregarious action.

Some 7 weeks after pupation the moths appear, their emergence being spread over a period of some 3 weeks. Where the round exit hole has been formed it appears that the moths use this for emergence, otherwise they apparently use the T-shaped hole. They squeeze through the opening when still wet and crawl a little distance upwards to unfold the wings and dry. Hatching of the moths takes place during the first half of the night, beginning at about 8 o'clock p.m. An infested culm may yield up to 70 or 80 moths. The longevity of the moths is 12—18 days.

Several attempts failed to have the moths copulate and oviposit in gauze cages provided with cut bamboo sprouts or live sprouts in the field. Therefore egg batches were collected from sprouts in bamboo groves in the neighbourhood of Bogor and

transmitted to sprouts in private yards where they could be kept under control and for regular inspection. Notwithstanding these precautions the number of cases where the whole process had its normal course was limited (in some 10 out of 30 experiments, taken at the time the habits of the borer had become roughly known).

There are several factors which endanger a successful development of the borer. (1) The eggs become covered with a fungus; (2) they turn black, being parasitized by a tiny wasp with red eyes, most probably a *Trichogramma* sp.; (3) they are destroyed by ants; (4) the infested part of a sprout is gnawn by a squirrel (to feed on the milky fluid rather than on the boring larvae, as a part of the larvae still can continue their development); (5) the top of the infested sprout withers which prevents the borers to develop; (6) a part of the pupae die; (7) a part of the emerged moths are crippled. It seems possible that factors 1, 3 and 7 are the result of unnatural conditions prevailing during the experiments.

According to the observations of Mr. SUDIRO attack by "tjangkilung" particularly occurs in dense bamboo groves in moist places. The semi-wild groves are attended to by the owners who thin out the sprouts to reduce a too abundant tillering and to use the sprouts as a vegetable.

The main hosts of the borer are *Gigantochloa apus* ("bambu tali"), the species most commonly grown in West Java, and *G. verticillata* ("bambu andong"). The internodes hollowed out and disfigured by the borer number 9—14 in a single culm; the total length of the affected part is 90—220 cm. Counts in the villages around Bogor have shown that some 9% of the bamboo culms were spoilt by this borer in the years 1941—1943. In the early months of 1944 strikingly less egg batches could be found in comparison to the three preceding years.

**Eschata chrysargyria** Walk., the borer from East Java is a lustrous white species, 36—40 mm. According to the very incomplete notes available, the habits of this species are quite different from those of the preceding borer. Young bamboo culms infested by *Eschata* have 1—4 internodes which outwardly show one or two small holes in the wall and a few black punctures, besides a dark ring at the top. From the holes sap may be oozing. The black rings are caused by a flat circular gallery bored in the inner wall of the cylinder just beneath a partition and interrupting the sapflow. A single larva or a pupa may be found inside an internode marked in this way. The pupa is enclosed between two spun membranes in the internode and is suspended head downwards from the upper membrane. This separate room also has a hole in the wall close to the head part of the pupa and apparently made by the larva before pupating. It is closed by silk and is used by the moth for emergence. The internodes occupied by the borer are not malformed and it seems that the larva mainly feeds on nutritious slimy matter ("legon") which accumulates in the internode.

The borer has been found in wild growing groves of *Bambusa vulgaris* ("bambu legi") and *Gigantochloa verticillata* ("bambu wulung") in the teak area of Central Java.

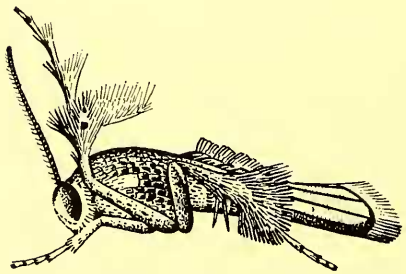
## 4. NOTE ON THE BIOLOGY OF *AMPHITALES EPISCOPOPA* MEYR. (AEGERIIDAE)

In April, 1937, the forest superintendent F. J. APPELMAN discovered an unknown disease of *Actinophora fragrans* (Tiliaceae, "walikukun") in an 8-year old plantation between Bondowoso and Situbondo, East Java, at 150 m altitude. The timber species had been used as an admixture in a plantation of teak (*Tectona grandis*). The *Actinophora* trees showed patches of very rough bark with fissures and excrescenses along their stems, which had a diameter of 4—12 cm (Pl. 8 fig. 5). The type of damage reminded the reporter of bark cancer ("Krebs"), some trees having the diseased parts all over the stem. In some parts of the plantation 75% and more of the trees had been affected.

An investigation of material submitted to the Instituut voor Plantenziekten at Bogor taught me that the injury apparently originated primarily from galleries of a small reddish caterpillar, made in the living bark of the trunks, particularly at the base of side branches and snags. This had led to the formation of fissures in the bark and to callus growth, while secundary fungi had killed part of the tissues. Additional galleries had been made along the margin of the wounds and had enlarged the sickly portions.

Some 19 specimens of a small peculiarly looking moth (text fig. 2) were bred between 25 May and 5 July, 1937, from infested stems sent to Bogor. Specimens of the species sent to the British Museum of Natural History were identified as *Amphitales episcopopa* Meyr. (det. STRINGER, 1939).

Similar damage to young *Actinophora* trees was found in Central Java later, but no further investigations have been carried out.



Text fig. 2. *Amphitales episcopopa* Meyr. (× 10; by Indonesian artist)

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